

## Final Examination

*Closed-book examination.* (Submit the problem sheet with answer sheets.)

2006.06.13

Answer the following questions as TRUE (T) or FALSE (F).. Each correct answer will be given 5 points. If you don't know the answer, please do not answer. **The wrong answer will be penalized by 5 points each.**

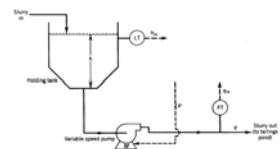
1. A cascade control system can be used for enhancing the dynamics of the master loop and overcoming disturbances in the master loop.
2. The reset feedback can overcome reset windup for cases where control loops are switched even with P control.
3. The Smith predictor can improve the controller performance when the time delay of the process is long.
4. The override control scheme can usually be used to reduce the energy usage.
5. A plant with low degree of integrity may become unstable when some of controller pairs are manual mode.
6. The positive relative gain less than unity implies that the closed-loop gain is smaller than open-loop gain.
7. A partial decoupler has tendency to be more sensitive to modeling error.
8. The most reliable interaction indicator covered in the class is the condition number based on the eigenvalue.
9. MPC can handle time operational objectives and constraints but not the economic objectives.
10. In MPC, the higher weighting factor on input movement will result more aggressive control action.
11. Most time-consuming step for MPC is to select the values of suitable tuning parameters.
12. The strategy of decreasing  $\beta$ -risk in SPC reduces the possibility of false alarm of a event.
13. The EWMA chart with high  $\alpha$  value takes into consideration of past data with more importance.
14. The standard deviation of EWMA chart is always larger than that of Schwart chart.

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Answer the following questions briefly. **No penalty** will be imposed for incorrect answer. (10 points each)

15. Explain how to tune a lead-lag feed forward controller.
16. State the stability of the system with the gain  $K$  for 1-1/2-2/3-3 pairing?
17. What kinds of limitations does the Smith predictor have?
18. What is the decoupler design principle to eliminate the interaction between control loops?
19. Complete the control system to maintain the level and exit flow around the normal operating condition while the exit flow should be kept above the minimum to prevent from sedimentation.

$$K = \begin{pmatrix} 0 & 1.0 & -0.8 \\ 1.1 & -0.8 & 1.7 \\ 0.2 & -0.4 & 1.3 \end{pmatrix}$$



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20. (50pts) For step response coefficient  $a_i$  and initial condition  $y_0$ ,
    - a) What is the predicted output value at time  $k$  ( $y_k$ ) if  $u_i$  ( $i=0, \dots, k-1$ ) are implemented?
    - b) What is the recursive form of the predicted output in a)?
    - c) What is the corrected prediction at  $(k+V)$  step ahead when the current measurement at  $k$  is available?
    - d) Derive the unconstrained DMC control law in the sense of minimization of weighted sum of squares of errors and input movements when predicted error  $\hat{\mathbf{E}} = -\mathbf{A}\Delta\mathbf{u} + \hat{\mathbf{E}}'$  and  $\hat{\mathbf{E}}'$  is known.